11621

CH2M824-S.3/GSTM.1
1/07/84

MEMORANDUM

TO: Gregg Kulma, U.S. EPA, RSPO
Mary Pat Tyson, U.S. EPA

FROM: Randy Videkovich/CH2M HILL, RSPM

DATE: January 9, 1984

PROJECT: W65225.00 - Old Mill Remedial Investigation/Feasibility Study, 47.5L25.0

SUBJECT: Geophysical Survey Technical Memorandum

PREPARED BY: Steve Carter/ESE, STL
Mike Geden/ESE, GNV

CC: Debbie Berg, Ohio EPA, NED
Gary Gifford, Ohio EPA, NED
Roger Hannahs, Ohio EPA, CO
Bob D'Agostaro, AZPM-REM, ZPMO, MAR/WDC
Bob Rosain, REQ V QAM, SEA
Mike Harris, RPTL, GLO

001595

INTRODUCTION

A geophysical survey was conducted at the Old Mill site in Rock Creek, Ohio, from October 17 to October 22, 1983. This survey was performed in accordance with specifications and objectives outlined for Subtask 2.1 in the Work Plan (final version--September 27, 1983) for the Old Mill RI/FS. The survey was conducted by personnel from CH2M HILL, Ecology and Environment, Inc. (E&E) and Environmental Science and Engineering, Inc. (ESE) with the aid of U.S. EPA personnel. This work was performed in partial satisfaction of Contract No. 68-01-6692, Work Assignment No. 47.5L25.0. The starting date of this survey was shifted from the week of October 3 to the week of October 17 at the request of U.S. EPA so that this activity would coincide with a public meeting of area residents which was conducted on October 19, 1983.

Conclusions drawn in this technical memorandum were based solely on the interpretation of the indirect geophysical data obtained during this survey. Correlation with direct subsurface data (e.g. boring logs, groundwater quality data) will be made in the RI report.

PURPOSE

The purpose of the geophysical survey was to characterize subsurface geologic conditions in and around both the Henfield and Kraus properties. The specific objectives were to:

1. define subsurface geologic features (depth to bedrock, variations in stratigraphy);

2. assess the conductivity and resistivity properties of subsurface materials (a zone of increased subsurface conductivity may be indicative of a contaminant plume); and

3. locate any buried metallic objects (drums, tanks, etc.).

SCOPE

The scope of the survey, as defined in the Work Plan, included the following elements:

1. Electromagnetic (EM) terrain conductivity survey--conducted onsite and offsite at both the Henfield and Kraus properties;

2. Electrical resistivity (ER) soundings--conducted along transects on both the Henfield and Kraus properties; and

3. Magnetometer survey--performed onsite at the Kraus property in accordance with the Work Plan.

Survey locations were determined in the field by the Geophysical Survey Coordinator and the Field Team Leader in consultation with the U.S. EPA RSPO. No environmental samples were collected during the geophysical survey. Details of the Old Mill geophysical survey are provided in the following sections of this memorandum.

SUMMARY OF FINDINGS

- ER sounding results indicate that the water table is shallow and may be encountered at a depth of 2 to 4 feet below ground surface.
- Depth to bedrock appears to be 10 to 20 feet on the Henfield property and 15 to 25 feet on the Kraus property.
- Bedrock below the Henfield property is likely to be tight and may not produce much water.

- Bedrock underlying the Kraus property may be more irregular (surface topography) and weathered and therefore yield more water than that below the Henfield property.
- A plume of higher subsurface conductivity was identified on the Kraus property during the EM survey. This plume, which appears to be moving toward the west-northwest, may have originated from a marshy area which was reportedly used as a disposal site for drilling brines. The plume does not appear to extend outside the Kraus property boundaries.
- No subsurface conductivity plumes were defined on the Henfield property, although EM survey results did identify three limited areas of higher conductivity (higher relative to adjacent onsite areas).
- Survey results gave no indication that buried drums or tanks were present on either the Henfield or Kraus properties.

SURVEY TEAM

The survey team for the Old Mill geophysical survey consisted of the following personnel:

Person	Company/Agency	Responsibility
Robert Fricke	E&E	Field Team Leader and Site Safety Officer
Mike Geden	ESE	Geophysical Survey Coordinator
Roberta Fine	CH2M HILL	Field Engineer
Gene Foster	ESE	Field Engineer
Steve Carter	ESE	ESE RSPM
Gregg Kulma	U.S. EPA	RSPO

GEOPHYSICAL SURVEY--HENFIELD PROPERTY

ER Soundings

ER soundings were performed along six survey lines (see Figure 1) on the Henfield property to characterize subsurface geologic and hydrogeologic features such as depth to bedrock, variations in stratigraphy, and depth of groundwater. Specifically, the ER soundings provided information on:

1. Variations in resistivity with depth;

2. The sequence of high and low resistivity zones; and

3. The depth to bedrock and to waterbearing strata.

Sounding lines were chosen in an attempt to best characterize the entire site while taking into consideration the distribution of existing structures on the property.

ER soundings were taken along each survey line using a Bison Earth Resistivity Meter (Model No. 2350) in accordance with the following procedures:

1. The center point for each survey line was located and a probe was driven into the ground at that location;

2. Survey lines (nylon ropes with marked intervals) were deployed from the center point in both directions along the survey line axis;

3. Four electrodes were then driven into the ground along the survey line axis (two on each side of the center probe) so that the distances between each electrode were equal (Wenner configuration, Figure 2). This distance between electrodes is referred to as the "A" spacing;

4. Electrical current was forced to flow from a battery into the ground through the outer two electrodes. The resulting voltage drop produced by this current in the earth was then measured across the inner two electrodes. This measurement yielded the resistivity value;

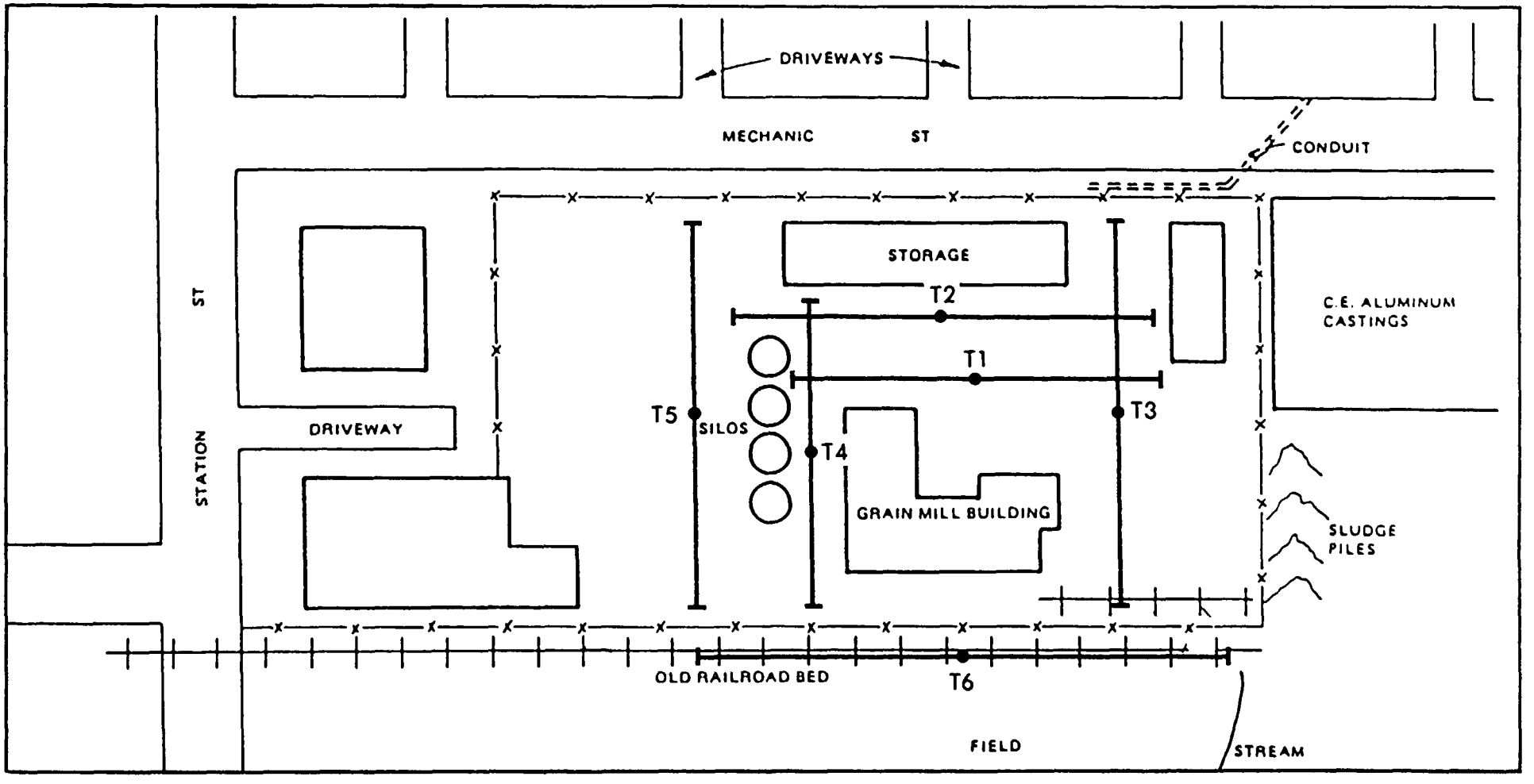
5. The electrodes were then moved, expanding the "A" spacing to the next predetermined interval and the resistivity was measured; and

6. This procedure was then repeated for the entire length of each transect.

The Wenner electrode configuration was used during the ER sounding survey. Using this configuration, electrodes were spaced at equal intervals ("A" spacing), with the intervals being expanded on a logrithmic scale as the sounding progressed along a transect. This logrithmic progression of "A" values provides more extensive information on near-surface resistivity values while enabling rapid completion of soundings to a sufficient depth along each transect. For the Old Mill ER Soundings, "A" values of 3, 5, 8, 12, 20, 30, 40, 60, 80, 100, and 150 feet were used, although the length of some transects were limited to less than this full sequence due to onsite obstructions (e.g. buildings, ballast piles).

Following completion of the survey, Apparent Resistivity values were calculated from instrument readings according to the following formula:

Apparent Resistivity = Instrument Reading x "A" Spacing



LEGEND

FENCE

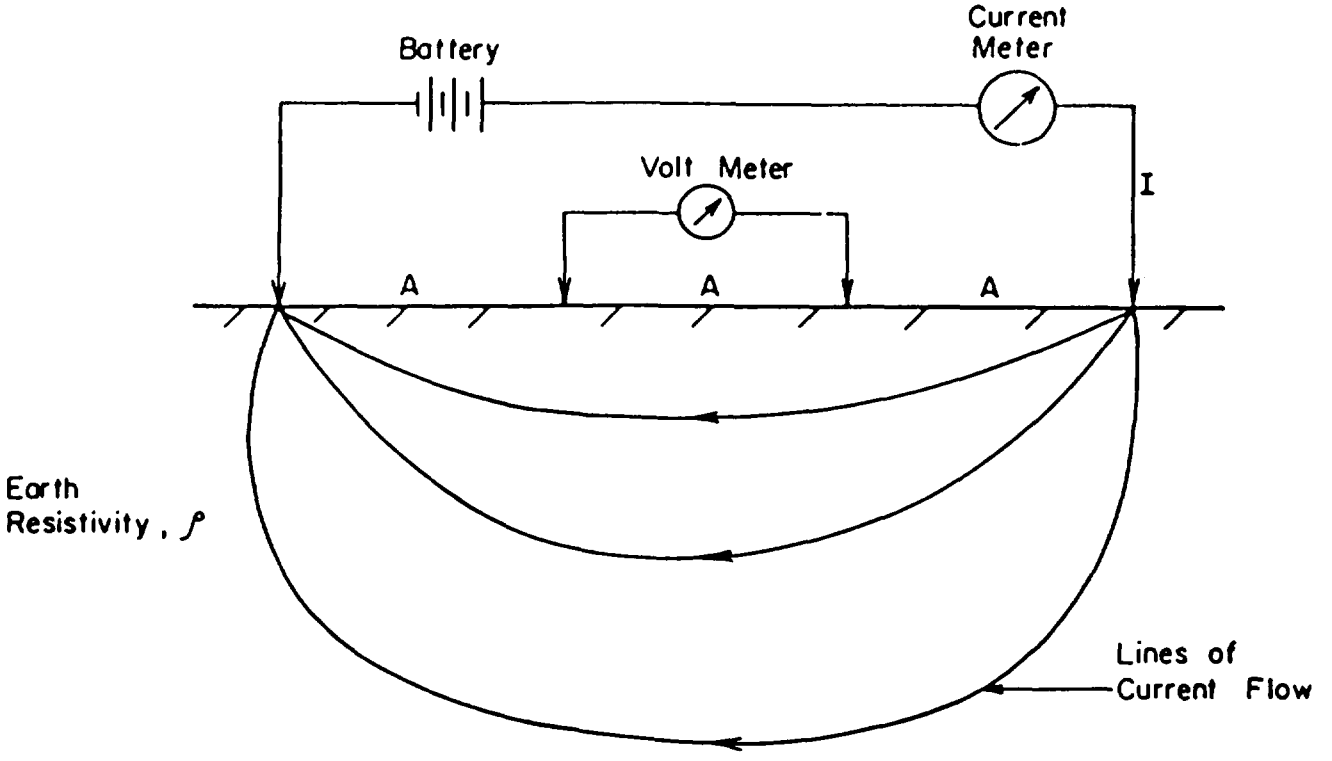
ER SOUNDING TRANSECT

TRANSECT MIDPOINT

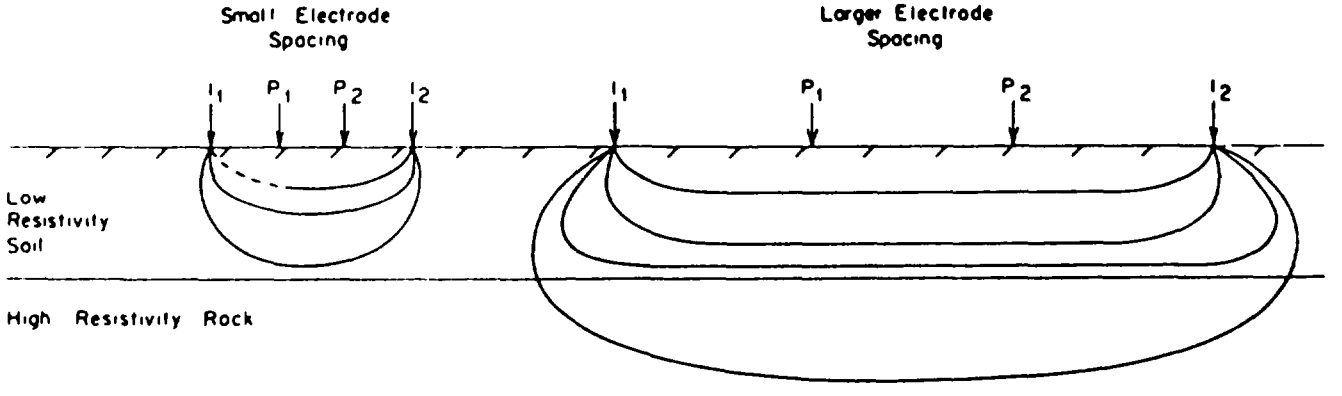
N

0 100

FIGURE 1
ER SOUNDING TRANSECT LOCATIONS
HENFIELD PROPERTY
OLD MILL SITE



Basic elements of an earth resistivity instrument



Effect of electrode spacing on current distribution

FIGURE 2
SCHEMATIC DIAGRAM SHOWING
THE OPERATING PRINCIPLES OF
AN ELECTRICAL RESISTIVITY INSTRUMENT
OLD MILL SITE

The apparent resistivity was then plotted against electrode spacing on logrithmic paper. Logrithmic plotting emphasizes the shallower portion of the subsurface section, which contributes a greater effect, proportionately, to the reading. The horizontal axis represents the electrode "A" spacing. Increasing "A" corresponds to increasing the depth of investigation. For small electrode spacings, the apparent resistivity is approximately equal to the true near surface resistivity. As electrode spacing increases, the sounding curve approaches gradually and smoothly toward the underlying resistivity, even though the layer boundries are sharp and distinct. In general, one can estimate the depth of different layers of resistance by assuming "A" is equal to 1.5 to 2 times the depth being measured.

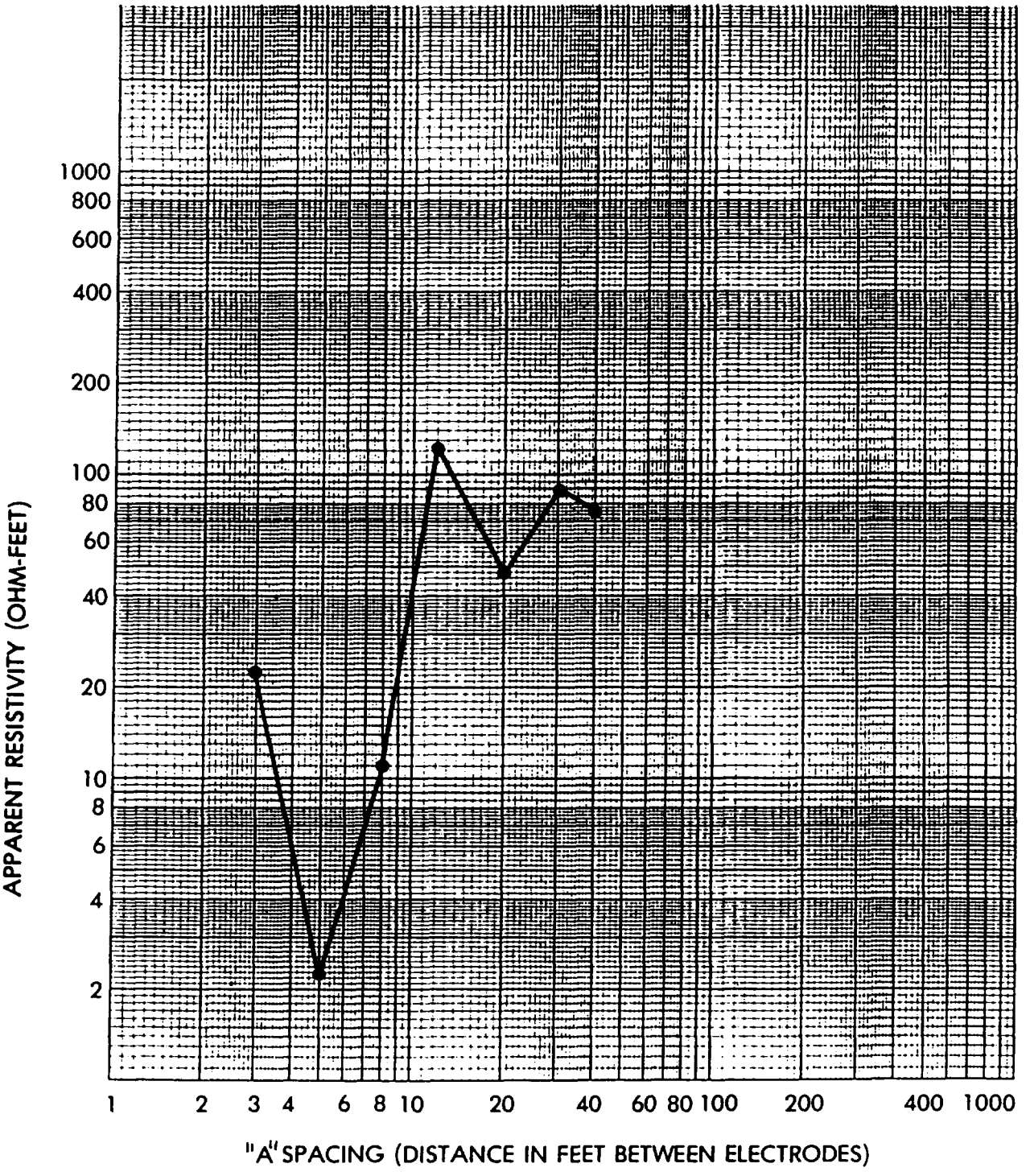
Resistivity sounding data from the Henfield property were interpreted empirically. The apparent resistivity points were connected by a smooth curve and slope changes were interpreted qualitatively. Increases in slope were assumed to represent increases in resistivity, whereas decreases in slope were assumed to be indicative resistivity decreases.

Apparent Resistivity values from Henfield Transects 1 through 5 are presented in Figures 3 through 7, respectively. Data from Transect 6 are not presented because the electrodes could not make proper ground contact along the railroad bed due to the presence of railroad ballast.

In general, ER soundings showed a slightly less resistive zone at a depth of approximately 2 to 4 feet throughout the Henfield property. This zone was less resistive than the rocky, cinder-mixed surface layer of soil and likely represents the top of the water table. Below the 2 to 4 foot depth, resistivity increased to a depth of 10 to 20 feet and then dropped off again. This second drop in resistivity may indicate a transmissive weathered zone at the bedrock surface. As the soundings were extended deeper into bedrock, resistivity increased. Resistivity values within the bedrock (assumed to be shale) were higher than those recorded for the surface zone. This suggests that the shale bedrock is likely to be tight and therefore may not yield much water. Survey results did not define subsurface geological conditions to the level of detail required for preparation of geological cross sections.

EM Survey

Following the ER soundings, an EM survey was conducted on the Henfield property. The lines for this conductivity survey generally followed the transect lines used for the ER soundings (see Figure 1). The survey lines were walked with a shoulder-carried terrain conductivity meter (Geonics Model No. EM-31) with data being recorded on a paper strip chart. As each line was



increasing "A" corresponds to increasing depth of investigation

increase in slope ≈ increase in resistivity

FIGURE 3
APPARENT RESISTIVITY VALUES
TRANSECT NO. 1
HENFIELD PROPERTY
OLD MILL SITE

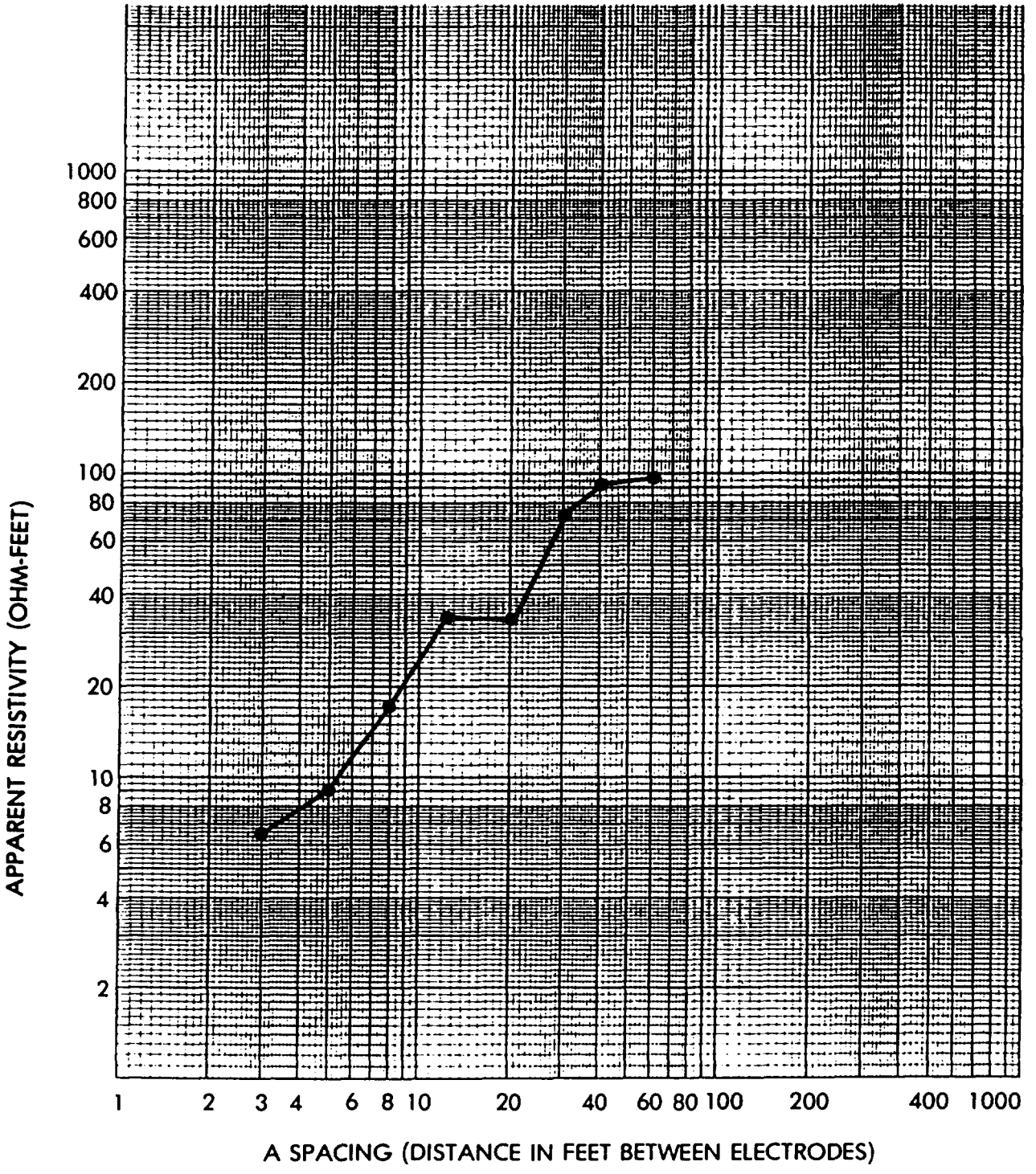


FIGURE 4
APPARENT RESISTIVITY VALUES
TRANSECT NO. 2
HENFIELD PROPERTY
OLD MILL SITE

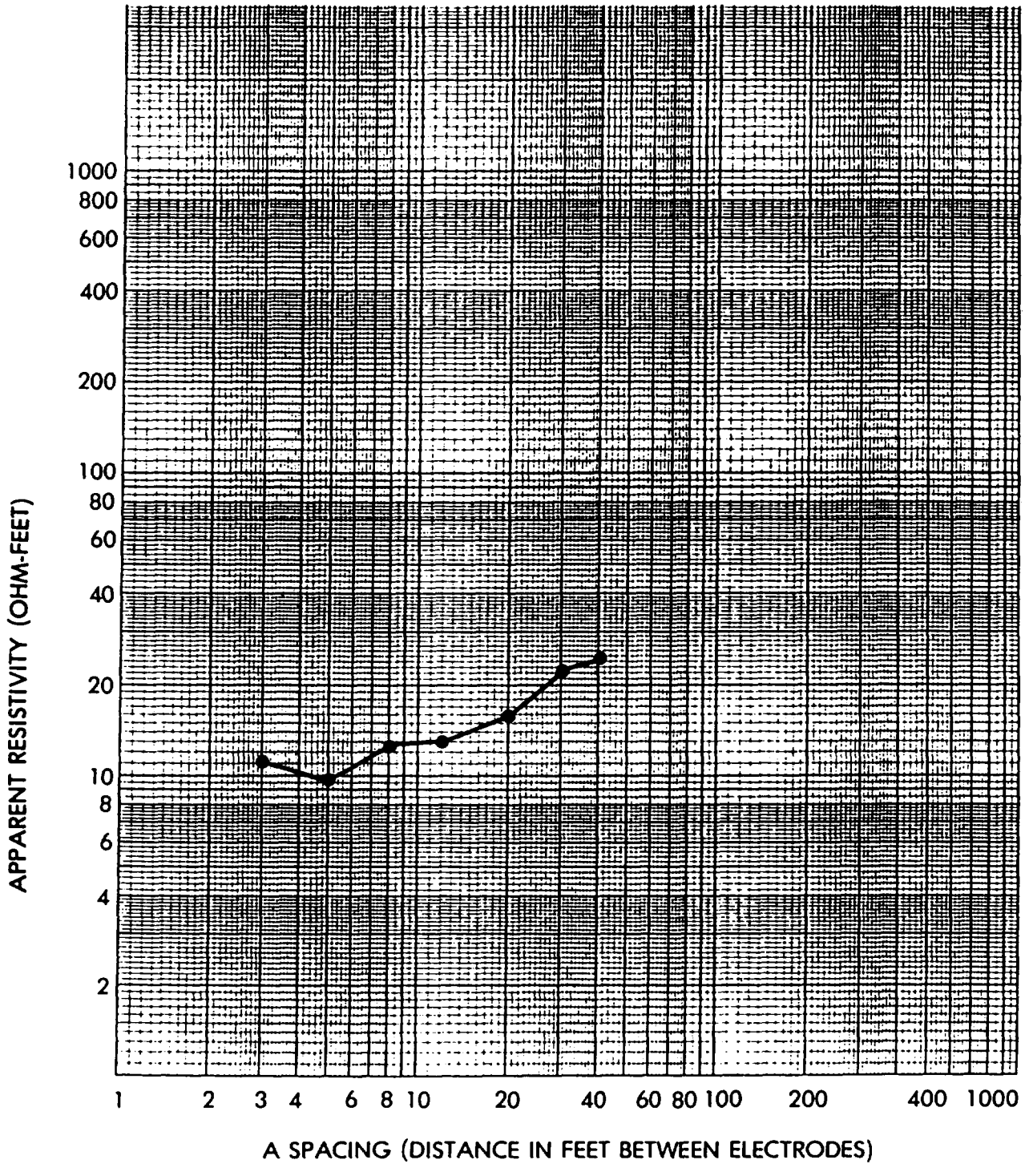


FIGURE 5
APPARENT RESISTIVITY VALUES
TRANSECT NO. 3
HENFIELD PROPERTY
OLD MILL SITE

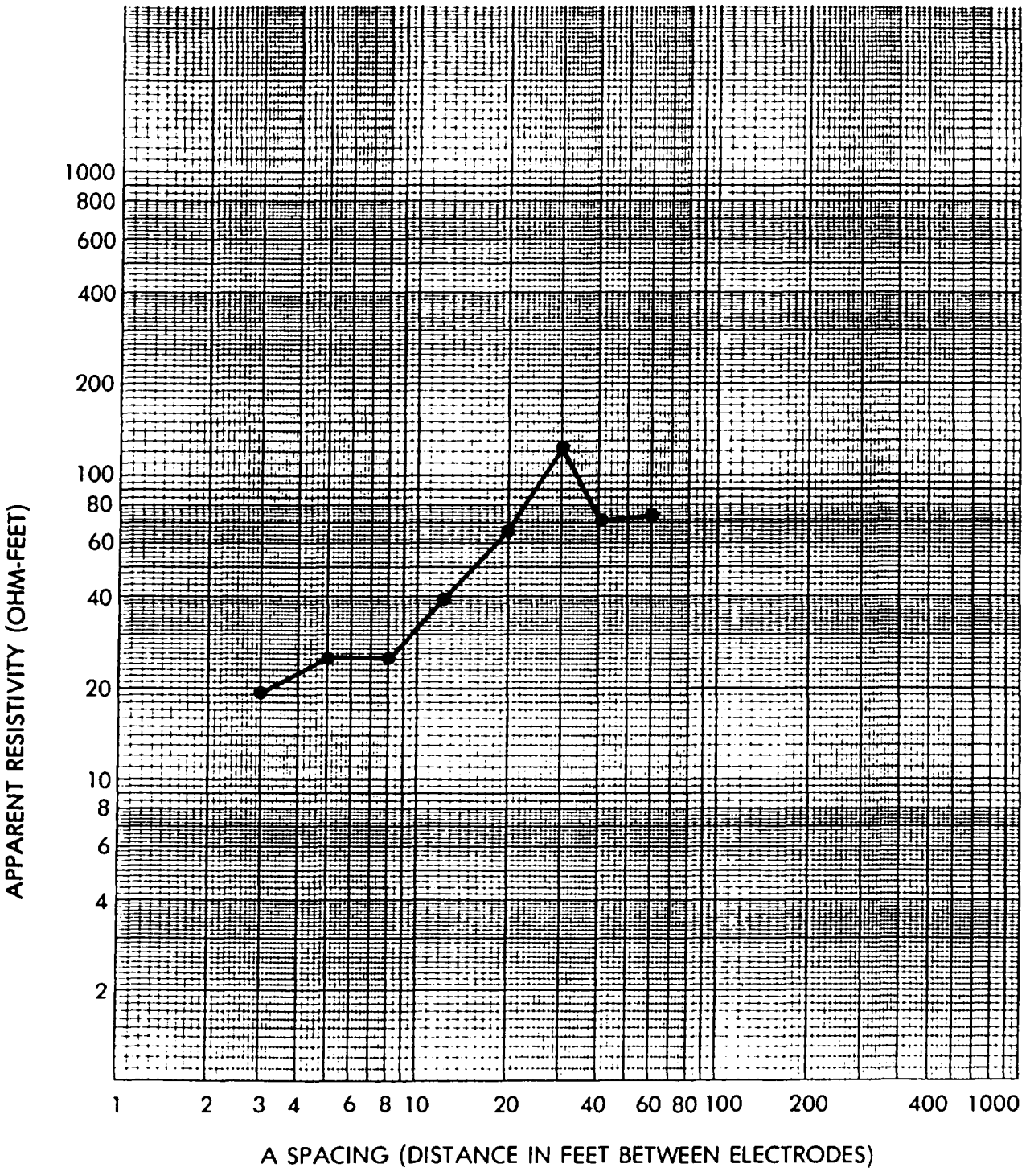


FIGURE 6
APPARENT RESISTIVITY VALUES
TRANSECT NO. 4
HENFIELD PROPERTY
OLD MILL SITE

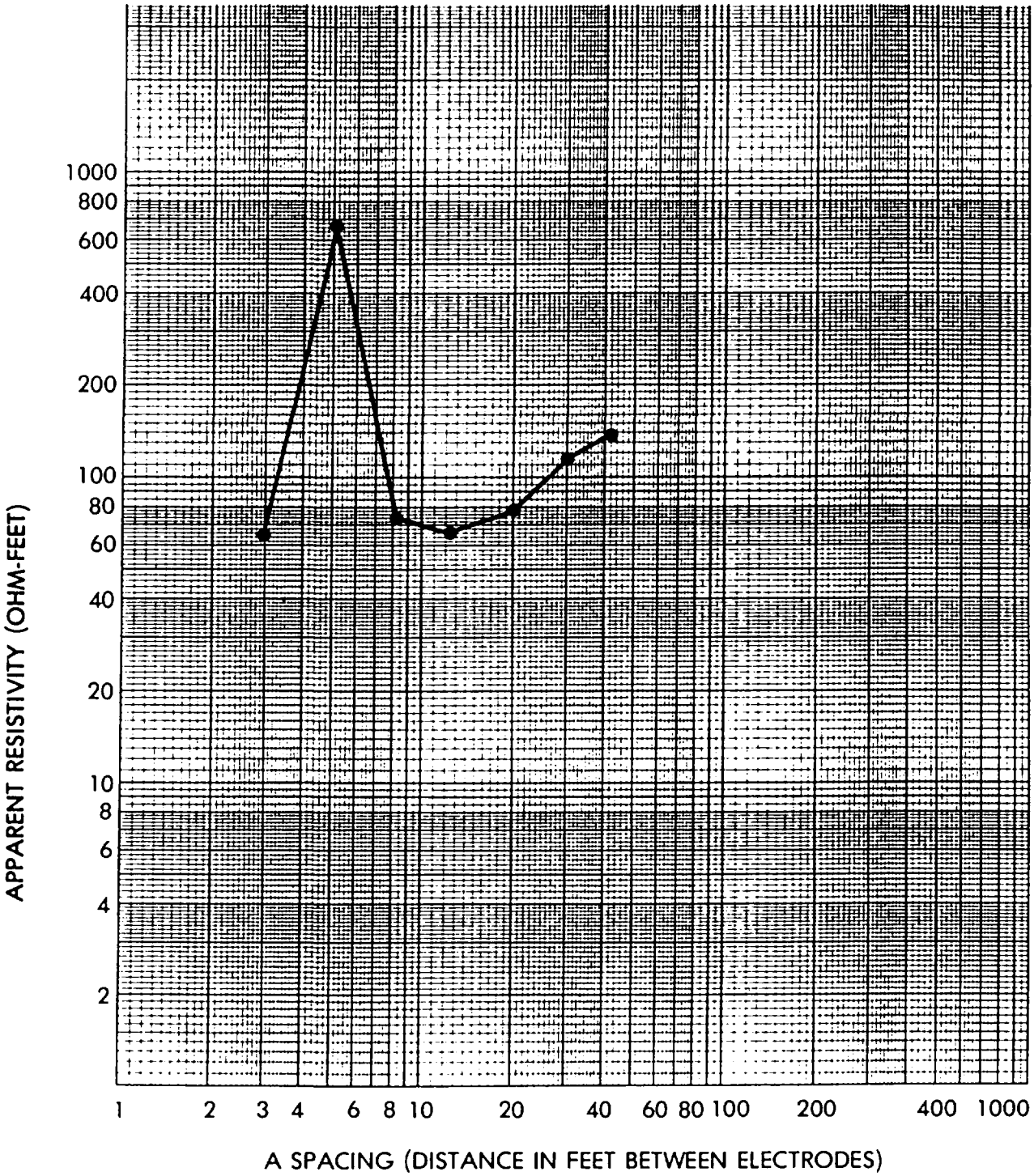


FIGURE 7
APPARENT RESISTIVITY VALUES
TRANSECT NO. 5
HENFIELD PROPERTY
OLD MILL SITE

walked, the strip chart was marked manually at 25-foot intervals to provide location reference points for subsequent data reduction. Where conductivity was noted to be higher, survey activities were intensified and the search expanded to define the areal extent of the higher conductivity values. Conductivity data from the Henfield EM Survey were interpreted empirically.

The results of the EM survey on the Henfield property were generally inconclusive. The presence of scattered metallic objects throughout the survey area, as well as the structural metal in the buildings, interfered with the ability of the instrument to accurately detect changes in subsurface conductivity. As a result, a magnetometer survey was conducted (see details below) following the EM survey to document the areal extent of interference from metallic objects on the Henfield property.

Three areas were identified during the study which were not as heavily affected by metallic trash interference and generally had higher sustained conductivity values than the surrounding areas (Figure 8). Because of the overall level of background interference on the Henfield property, and the limited size and distribution of these three zones of higher conductivity, no definitive conclusions can be drawn as to their origin or significance.

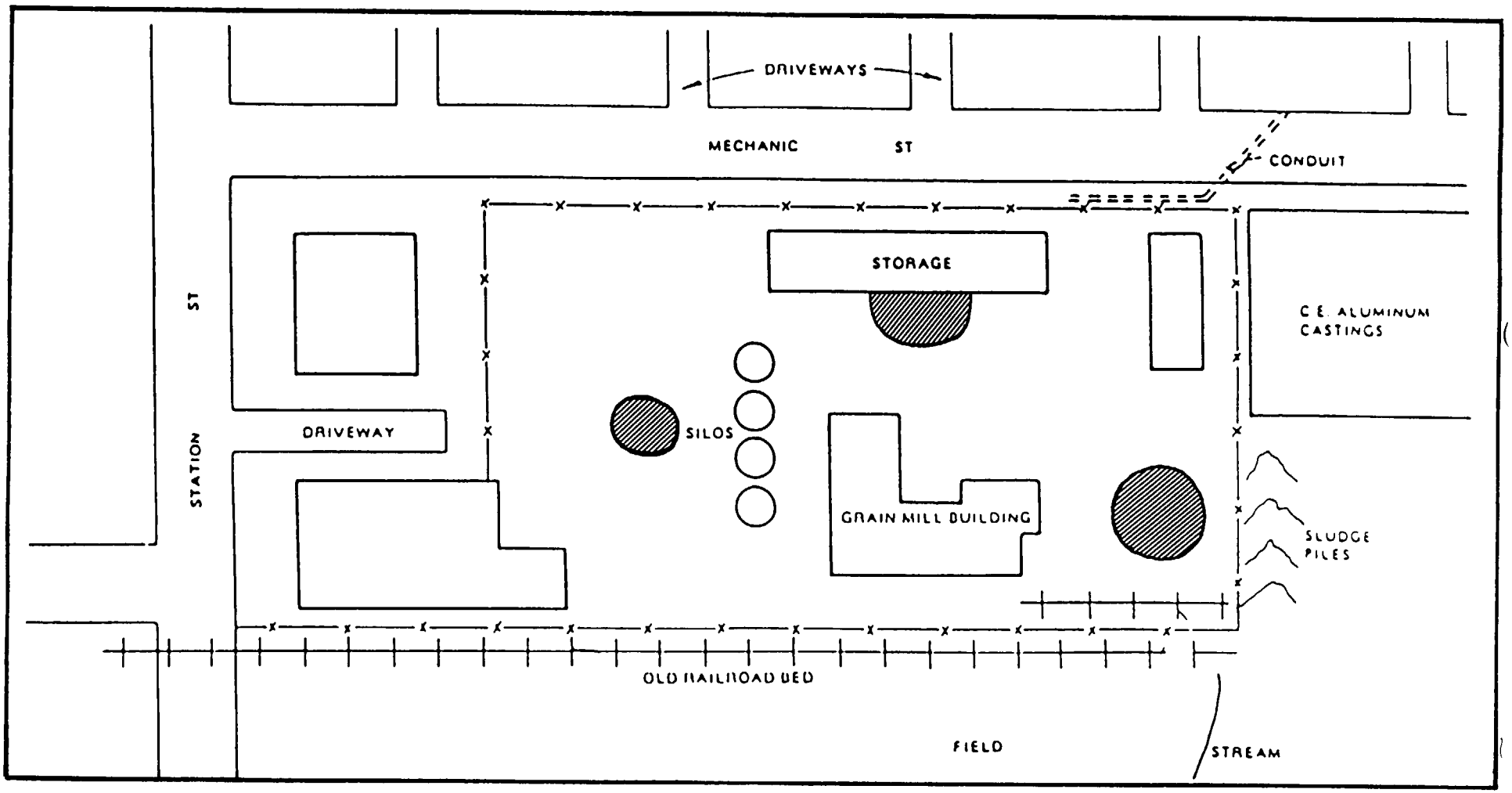
Magnetometer Survey

A magnetometer survey was conducted on the Henfield property following the EM survey. The survey was performed with a hand-held fluxgate gradiometer (Schoenstedt Model No. MA-83) generally along the same survey lines as the EM survey. The primary objective of the magnetometer survey was to check locations which registered higher conductivity during the EM survey to see if the higher readings were the result of buried metallic objects. As was discussed previously, considerable background interference was detected throughout the property. The magnetometer survey did not locate any large buried metallic objects (e.g. drums or tanks) on the Henfield property.

GEOPHYSICAL SURVEY -- KRAUS PROPERTY

EM Survey

An EM survey was performed on the Kraus property and its adjacent boundaries (Figure 9) with the Geonics terrain conductivity meter. The EM survey technique was identical to that described for the Henfield property, with the data being recorded on strip charts and position markings made at 25 foot intervals.



LEGEND

FENCE

AREA OF HIGH ELECTROMAGNETIC CONDUCTIVITY VALUES

N

0 100

50

SCALE IN FEET

FIGURE 8
RESULTS OF EM SURVEY
HENFIELD PROPERTY
OLD MILL SITE

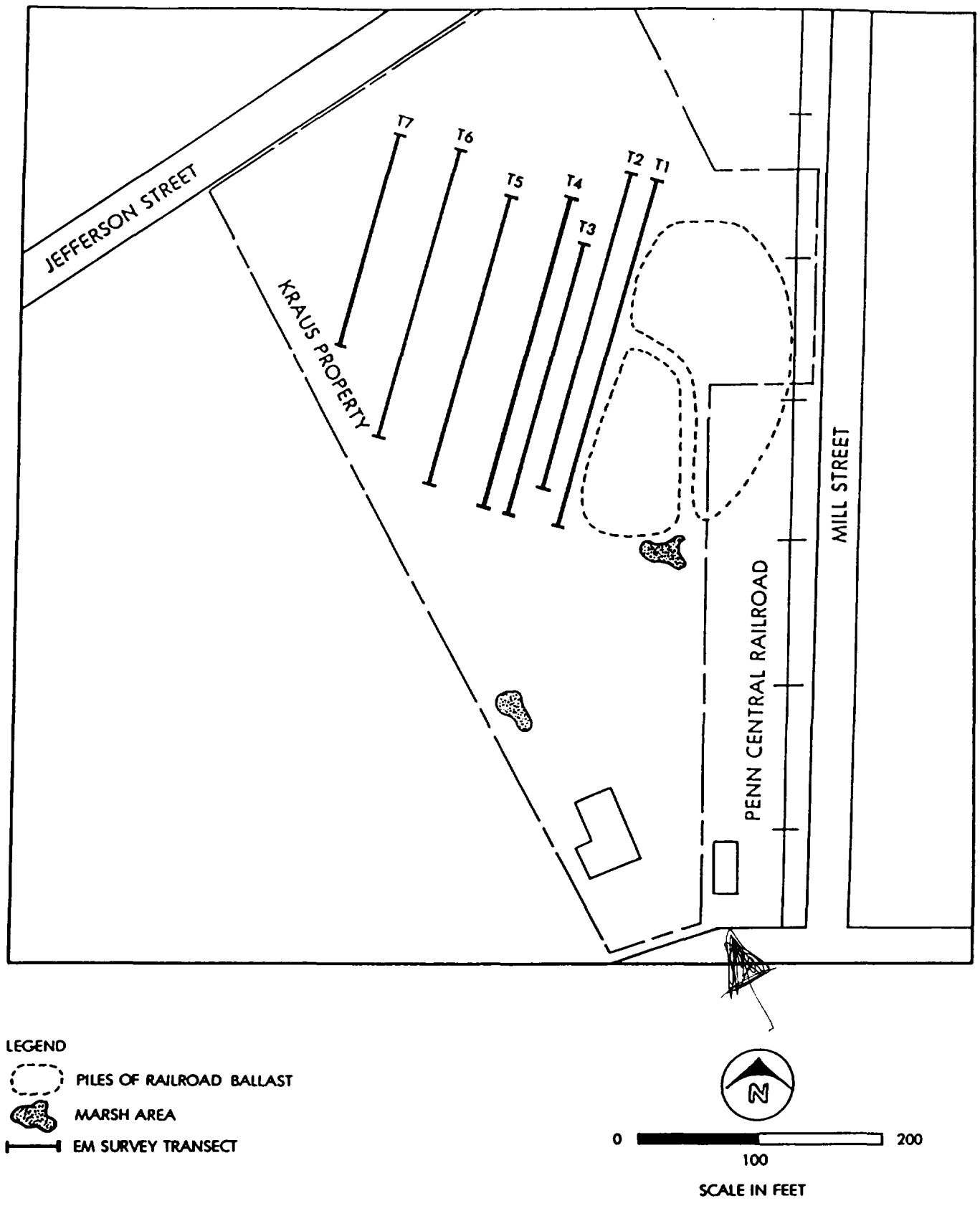


FIGURE 9
EM SURVEY TRANSECT LOCATIONS
KRAUS PROPERTY
OLD MILL SITE

Initially, the entire perimeter of the Kraus property was surveyed to see if there was any evidence of offsite movement of a conductive contaminant plume. Following the perimeter survey, background conductivity measurements were taken over some piles of railroad ballast located at the southeast corner of the intersection of Mill and Jefferson Streets (northeast of the Kraus property). Background readings were taken to determine the relative conductivity of the ballast material prior to initiating the survey of the onsite ballast piles.

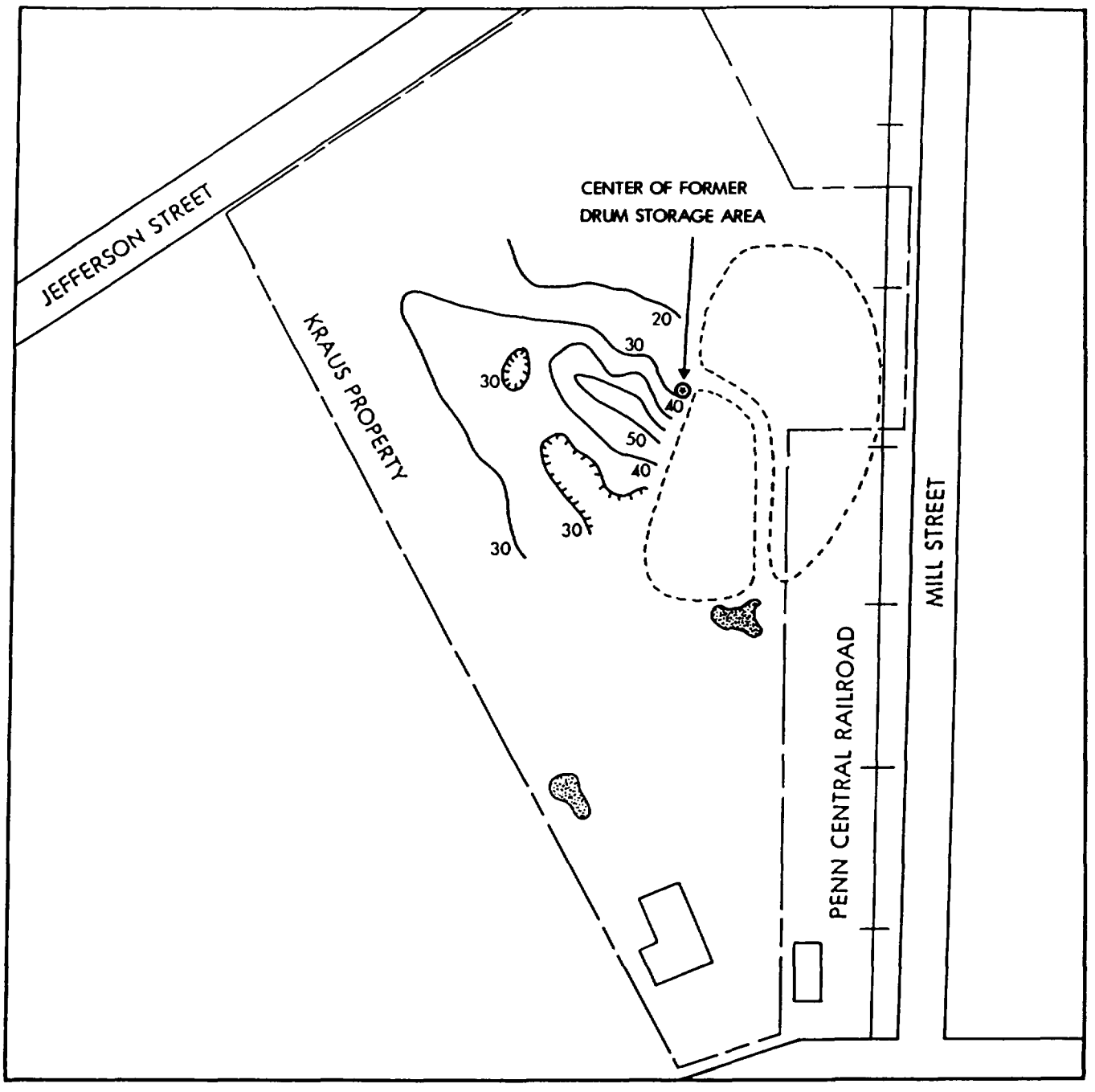
Following the perimeter and background ballast surveys, the EM survey team moved onsite and established a rough grid pattern in the open area on the northern end of the Kraus property, north and west of the former drum storage area and the ballast piles. The survey grid was established in this area because it was thought that groundwater flow was generally toward the northwest. Therefore, any contaminant plume emanating from the former drum storage and ballast pile areas would be intercepted along this survey grid.

Seven transects were established along parallel northeast-southwest lines spaced 50-100 feet apart (Figure 9). Readings were taken every 25 feet along each transect.

Conductivity data from the perimeter survey and ballast pile walkovers were interpreted empirically. Conductivity values from the seven-transect grid on the northern portion of the Kraus property were plotted on a base map and conductivity isopleths were then constructed by connecting points of equal value (at 10 millimhos/meter intervals). The resulting isopleths delineated zones of higher and lower conductivity throughout the grid area.

The EM survey of the Kraus property perimeter yielded generally low, steady conductivity readings which were interpreted to be background levels. Perimeter values did increase slightly in the area of the intersection of Mill and Station streets. This minor increase may have been due to the presence of overhead and buried utility lines as well as the large metal tanks located on the northwest corner of this intersection. The perimeter survey provided no evidence that a subsurface conductive plume was migrating offsite. The walkover survey of the offsite railroad ballast also produced background readings which were similar to values measured during the perimeter survey.

The results of the survey along the seven transects within the northern portion of the Kraus property did show a subsurface plume of higher conductivity moving in a west-northwesterly direction (see Figure 10). This plume appears to be moving away from an area approximately 100 feet southwest of the former drum storage area. This plume is not thought to originate from the drum storage area but rather in the vicinity of a marshy area which was reportedly used for



LEGEND

PILES OF RAILROAD BALLAST

MARSH AREA

CONDUCTIVITY ISOPLETH
(MILLIMHOS/METER)

N

0 100 200

SCALE IN FEET

FIGURE 10
ELECTROMAGNETIC CONDUCTIVITY VALUES
EM SURVEY
KRAUS PROPERTY
OLD MILL SITE

disposal of drilling brines. Conductivity values returned to background levels (16 to 20 millimhos/meter) before the edge of the property, indicating that the conductive plume apparently had not migrated offsite.

ER Survey

An ER survey also was conducted onsite within the northern portion of the Kraus property. Soundings were taken with the Bison Earth Resistivity Meter along 4 transects which were oriented northeast to southwest and spaced parallel to each other at 50 foot intervals (Figure 11). Soundings also were taken along three transects on the east and southeast portions of the Kraus property (including the strip of land owned by the Penn Central Railroad). Survey activities in the southeastern portion of the property were hampered by the presence of many old vehicles, which limited the position and length of the transect lines. Railroad ballast also hampered ER survey activities along the east side of the property.

Apparent Resistivity data were plotted against electrode spacing on logrithmic paper and analyzed empirically. Apparent Resistivity values from Kraus Transects 1 through 7 are presented in Figures 12 through 18, respectively.

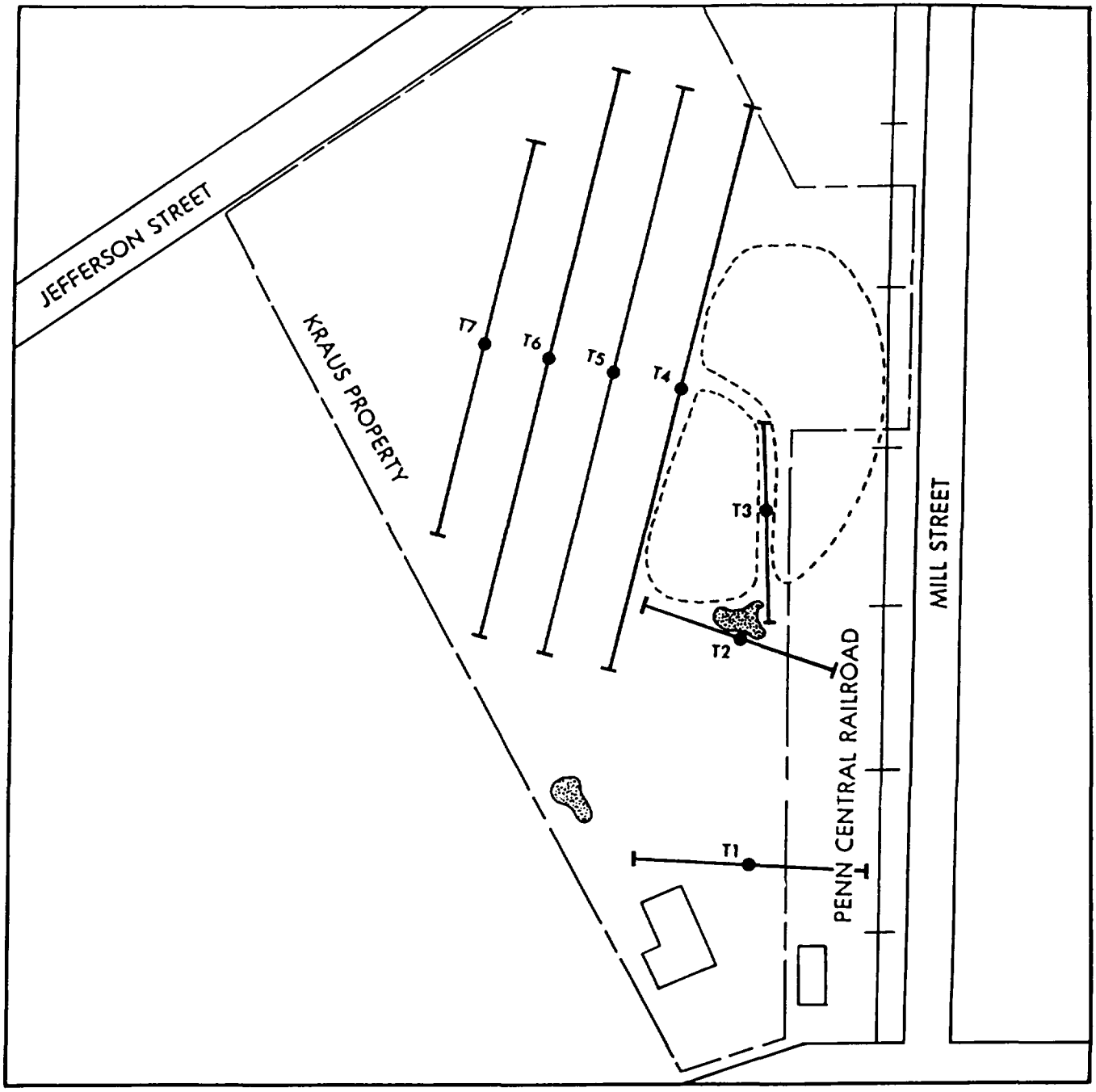
The results of the ER soundings on the Kraus property were not as consistent as those on the Henfield property. A zone of lower resistivity was detected at a depth of approximately 2 to 4 feet througout the Kraus property. Again, this zone appears to represent the top of the water table.

Below the 2 to 4 foot depth, ER values were irregular and did not indicate any consistent trends. These irregular readings may be indicative of irregular or disturbed bedrock topography. Bedrock under the Kraus property also may be in a more weathered state than that underlying the Henfield property. Irregular topography and more advanced weathering could have contributed to the formation of scattered zones of higher transmissivity, thus accounting for the pockets of lower resistivity observed during the survey.

Based on the survey results, bedrock underlying the Kraus property will be encountered at a depth of 15 to 25 feet. It is also felt that the bedrock in this area will be less competent than that underlying the Henfield property and, therefore should produce more water. Survey results did not define subsurface geological conditions to the level of detail required for preparation of geological cross sections.

Magnetometer Survey

A magnetometer survey also was conducted along the EM transect lines in the northern portion of the property as well as in the former drum storage areas and railroad ballast piles. The survey consisted of a general walkover of



LEGEND

PILES OF RAILROAD BALLAST

MARSH AREA

ER SOUNDING TRANSECT

TRANSECT MIDPOINT

N

0 200

100

SCALE IN FEET

FIGURE 11
ER SOUNDING TRANSECT LOCATIONS
KRAUS PROPERTY
OLD MILL SITE

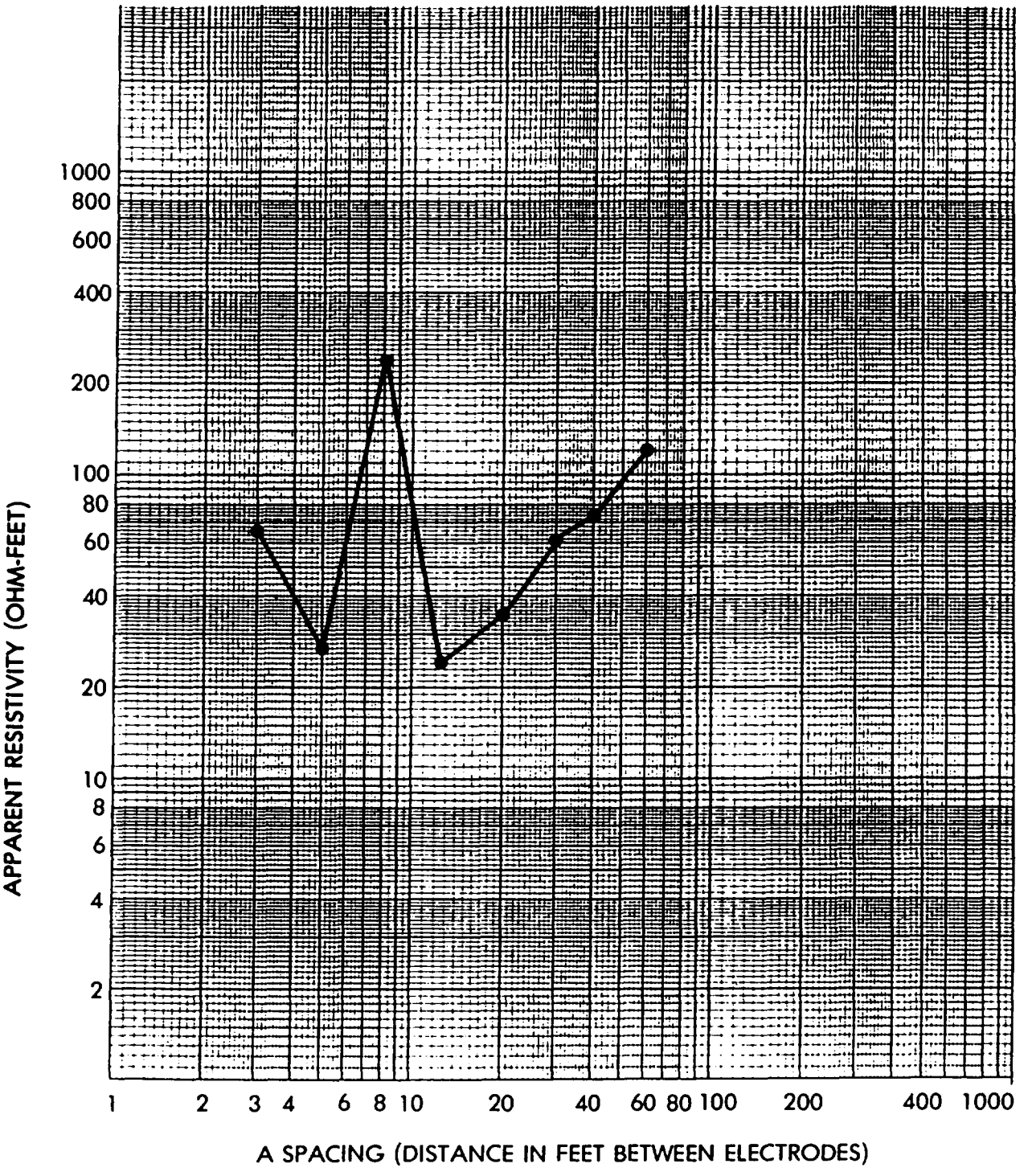


FIGURE 12
APPARENT RESISTIVITY VALUES
TRANSECT NO. 1
KRAUS PROPERTY
OLD MILL SITE

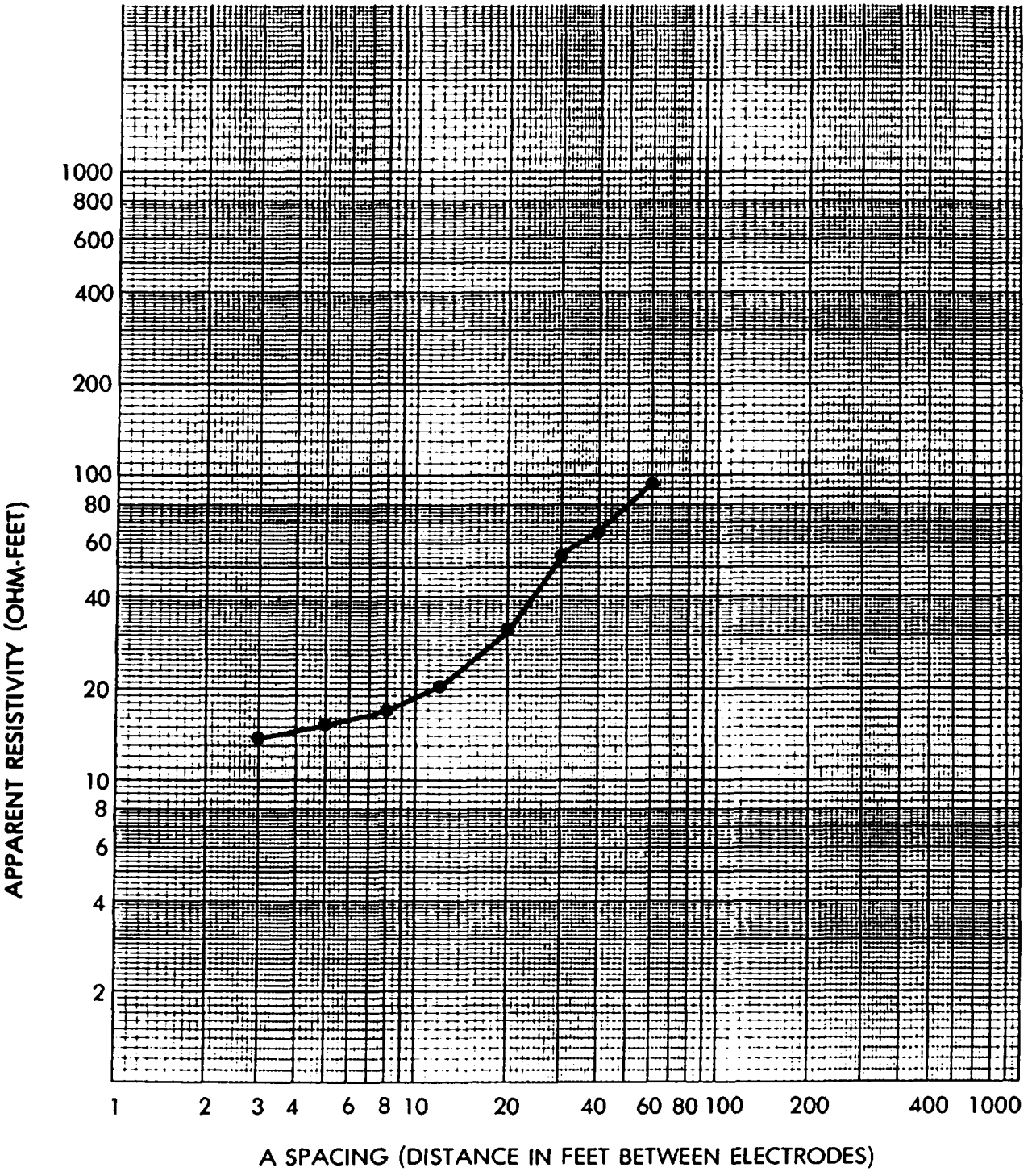


FIGURE 13
APPARENT RESISTIVITY VALUES
TRANSECT NO. 2
KRAUS PROPERTY
OLD MILL SITE

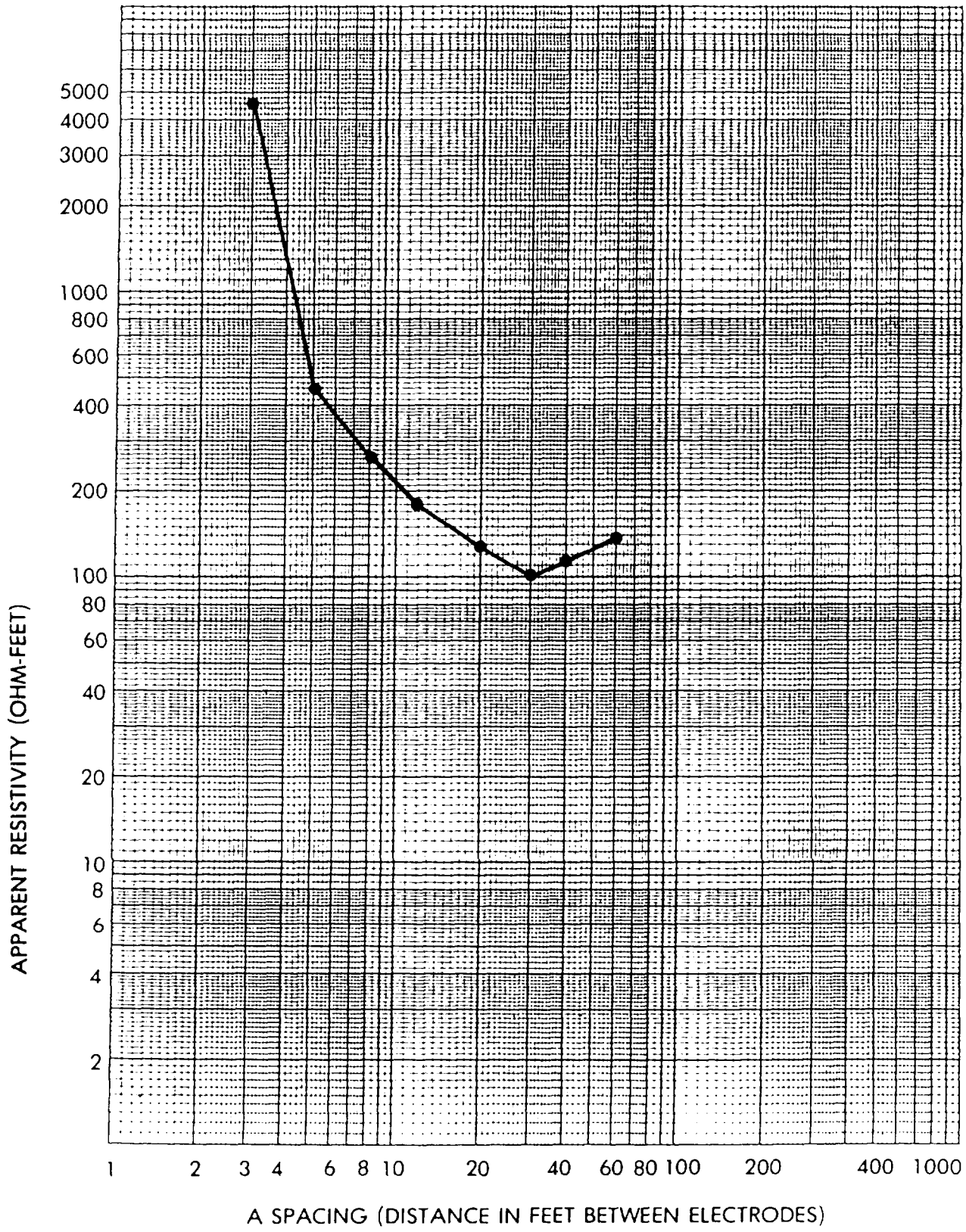


FIGURE 14
APPARENT RESISTIVITY VALUES
TRANSECT NO. 3
KRAUS PROPERTY
OLD MILL SITE

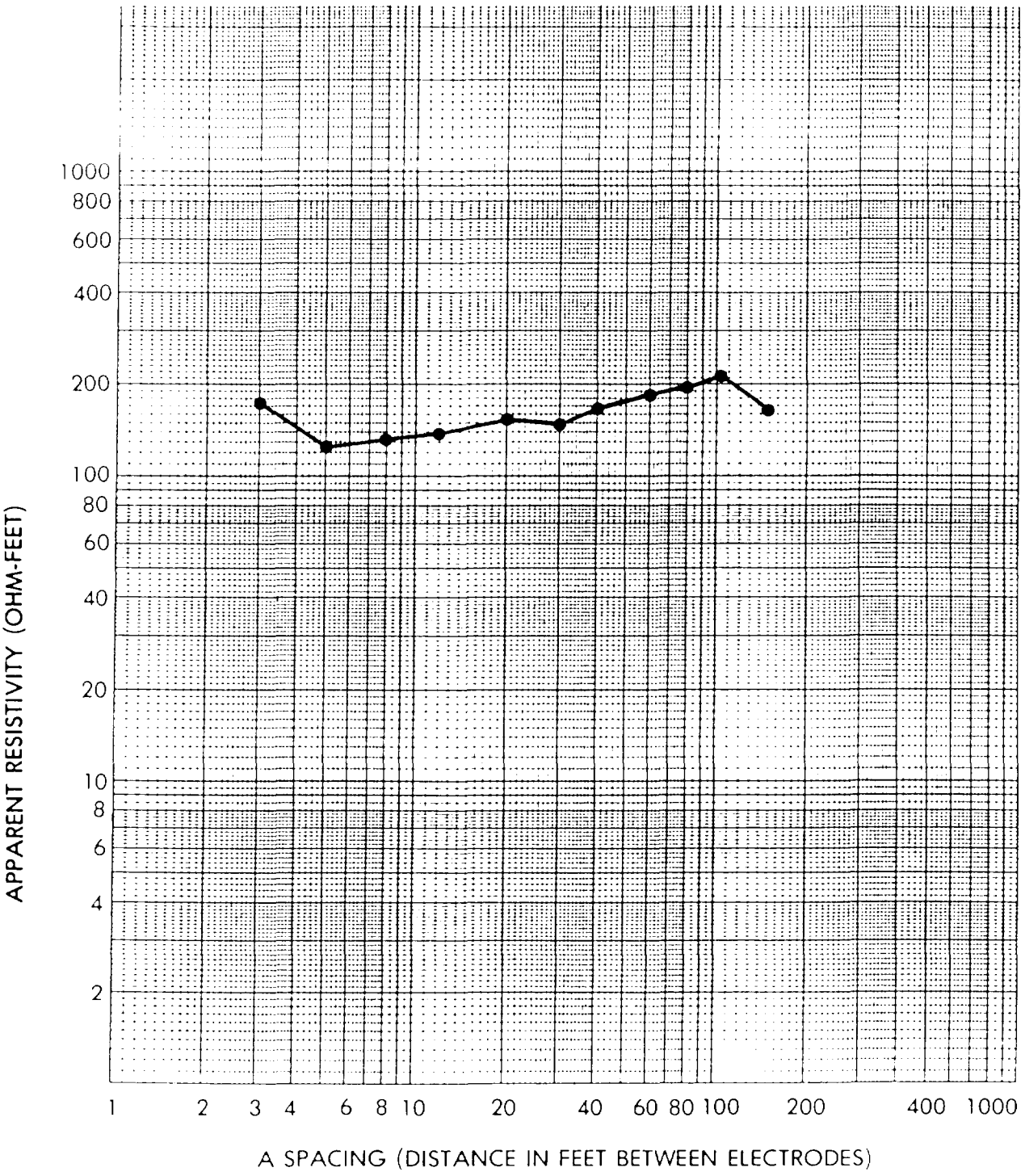


FIGURE 15
APPARENT RESISTIVITY VALUES
TRANSECT NO. 4
KRAUS PROPERTY
OLD MILL SITE

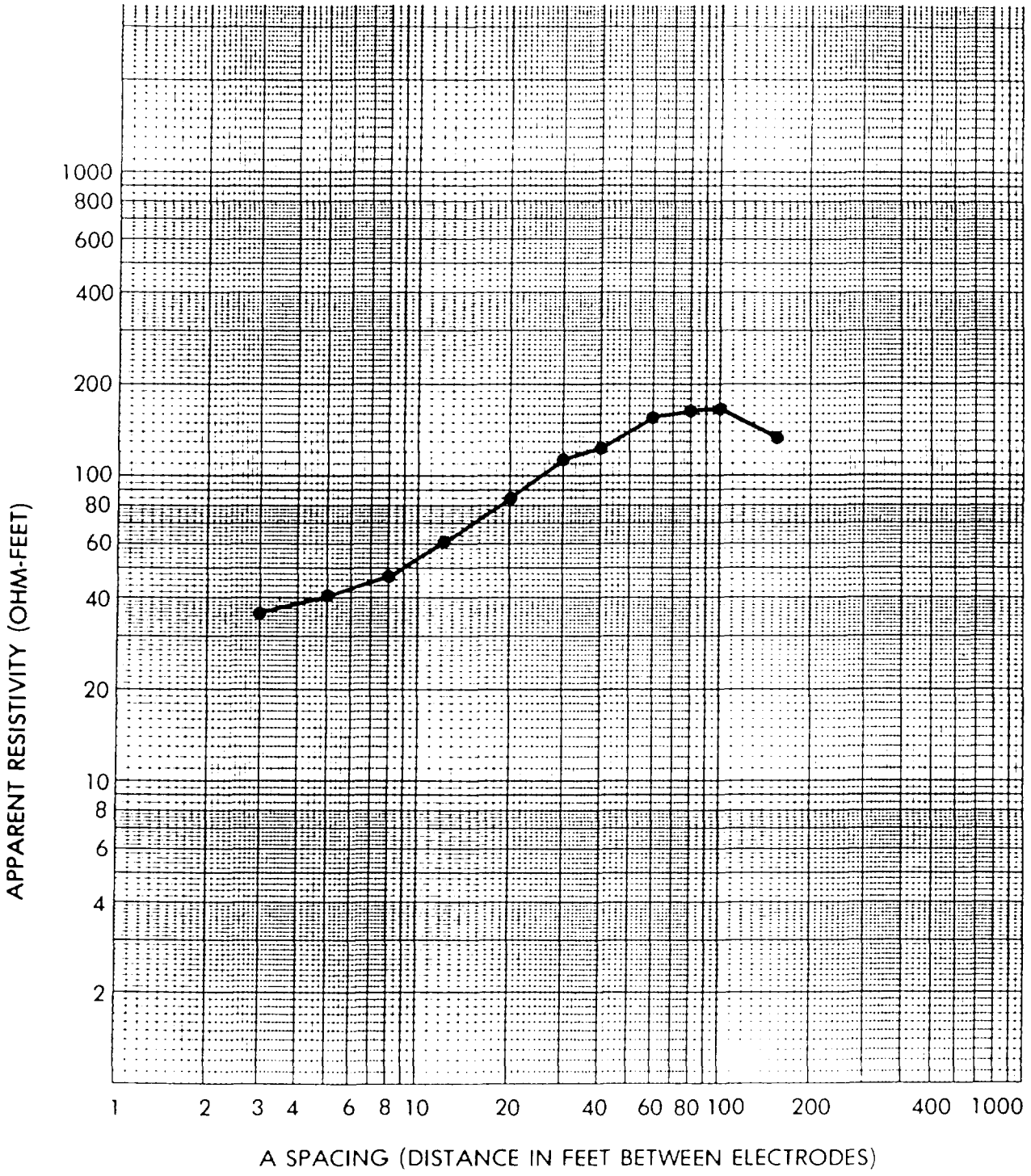


FIGURE 16
APPARENT RESISTIVITY VALUES
TRANSECT NO. 5
KRAUS PROPERTY
OLD MILL SITE

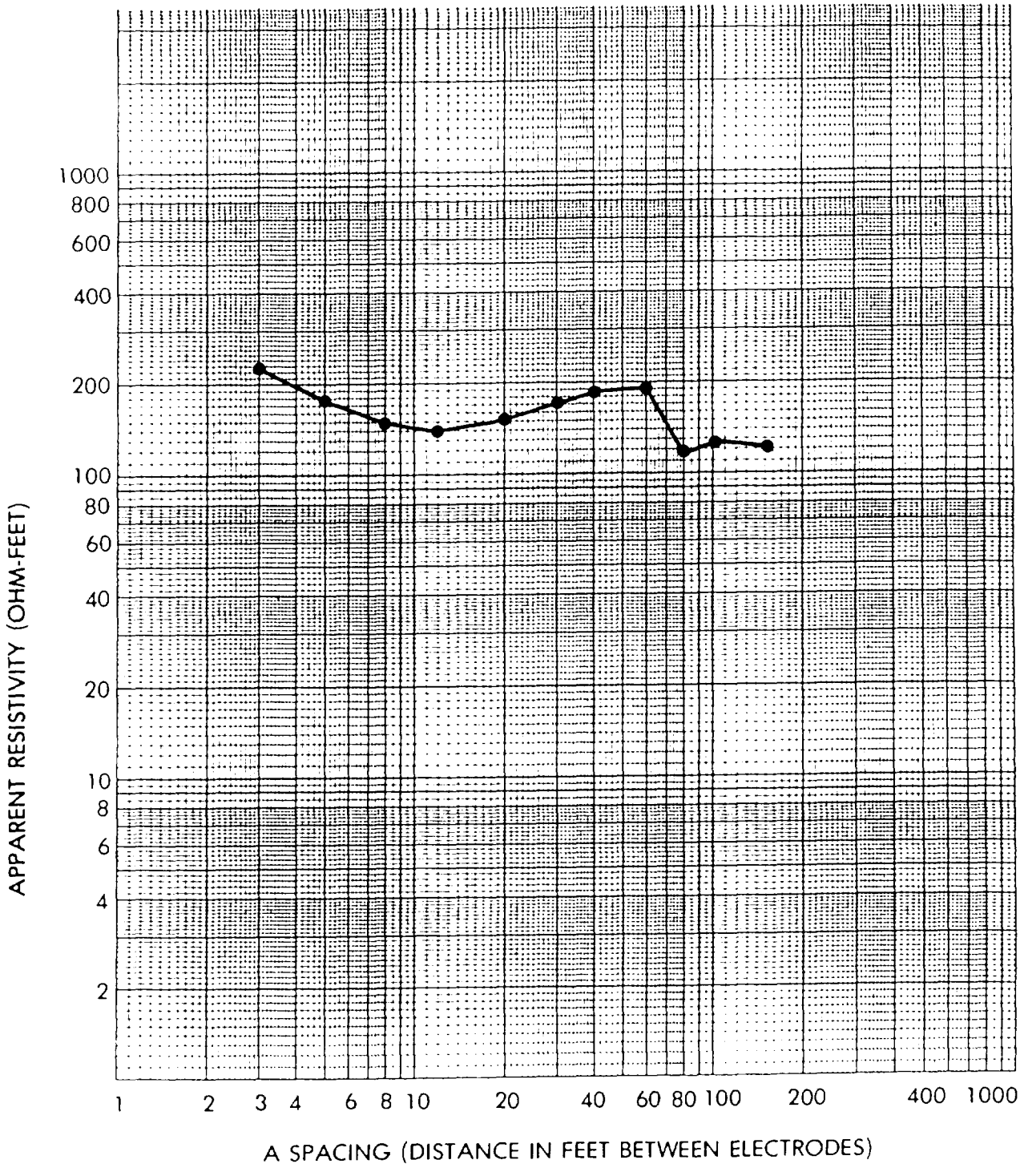


FIGURE 17
APPARENT RESISTIVITY VALUES
TRANSECT NO. 6
KRAUS PROPERTY
OLD MILL SITE

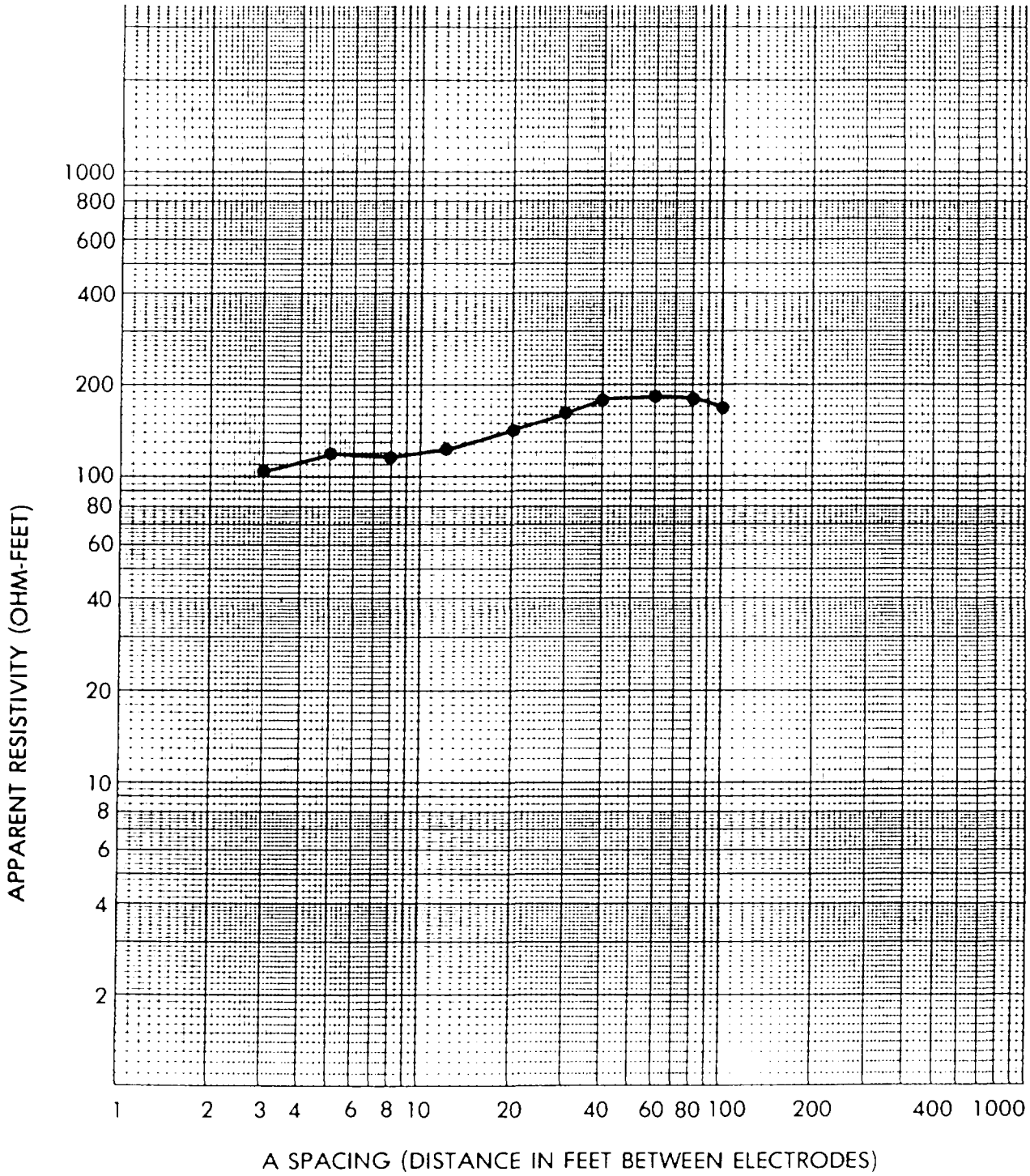


FIGURE 18
APPARENT RESISTIVITY VALUES
TRANSECT NO. 7
KRAUS PROPERTY
OLD MILL SITE

these areas using the Schoenstedt fluxgate gradiometer. The primary purpose of the survey was to look for indications of buried metallic objects (e.g. drums or tanks).

The magnetometer survey gave no indication of the presence of buried drums or tanks either in the northern field area, the former drum storage area or under the piles of railroad ballast.

CONCLUSIONS

The following conclusions can be drawn from the geophysical survey conducted on the Henfield property:

1. Electrical resistivity soundings showed a slightly less resistive zone at a depth of 2 to 4 feet. This zone is thought to represent the top of the water table.

2. Resistivity values generally increased from the top of the water table down to a depth of 10 to 20 feet and then dropped off again. This drop in resistivity past the 10 to 20 foot depth is thought to represent a weathered transmissive zone at the bedrock surface.

3. Bedrock below the Henfield property is likely to be tight and therefore may not produce much water.

4. Results of the electromagnetic terrain conductivity survey were generally inconclusive. The presence of scattered metallic objects and structural metal interfered with the accurate measurement of subsurface conductivity.

5. Three areas of higher conductivity were noted on the Henfield property. However, no definitive conclusions can be drawn at this time as to their origin or significance.

6. The magnetometer survey did not locate any large buried metallic objects (e.g. drums or tanks) on the Henfield property.

The following conclusions can be drawn from the geophysical survey conducted on the Kraus property:

1. A plume of higher subsurface conductivity was identified on the Kraus property. This plume was oriented in a west-northwesterly direction and appeared to originate in the vicinity of a marshy area located

approximately 100 feet southwest of the former drum storage area. The marshy area was reportedly used as a disposal site for drilling brines.

2. The conductivity plume did not extend outside the Kraus property boundaries.

3. Electrical resistivity soundings identified a slightly less resistive zone at the 2 to 4 foot depth which likely represents the water table.

4. Resistivity values below the 2 to 4 foot depth were irregular and may be indicative of irregular or disturbed bedrock topography or bedrock in a more advanced state of weathering than that underlying the Henfield property.

5. Depth to bedrock on the Kraus property is apparently between 15 and 25 feet.

6. The magnetometer survey gave no indication of buried drums or tanks on the Kraus property.